THE MODEL ENGINEER

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The MODEL ENGINEER

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SMOKE RINGS

Our Cover Picture

● DURING THE war, many women found employment in the Railway Service, and some are still so employed. They acquitted themselves creditably in a variety of jobs such as porters, ticket-collectors, guards, signalwomen and even gangers. One of the more unusual jobs, however, was that of "lamp-woman"; it requires, perhaps, a steadier nerve than most of the other jobs, because it includes attention to signal-lamps, many of which are close to the tops of tall, and often none-too-steady, signal-posts. Our picture shows one of these "lamp-women" at work, and she appears to be quite self-possessed and unconcerned!

His Life Was Changed

● AMONG THE many personal letters I received on our fiftieth anniversary I came across this sentence :—"I well remember the first number of THE MODEL ENGINEER and, soon after, my first contribution. Its publication changed the whole course of my life for the better." When I think that my correspondent afterwards occupied for many years an important technical position in one of the largest motor car works, became a Championship Cup winner at the "M.E." Exhibition, and was a leading light in one of the happiest model engineering clubs, I cannot help feeling that in my early days, in producing THE MODEL ENGINEER, I was sowing good seed. My correspondent, now retired from active work, still contributes an occasional item of practical interest to our columns and I cordially echo his wish that we may continue to correspond for years to come. These old friendships are very pleasant.

Films and Slides

● THIS BEING the season when many model clubs are concerned with providing attractive lectures for their members, there is a general demand for interesting films and lantern slides. Quite a number of good films in the 16 mm. size have been taken during the past year or two, illustrating various aspects of the model making hobby, but the existence of these films and their availability for borrowing or hiring is not very widely known. We should be glad if film owners who would be willing to lend them out for club use would kindly let us know the subjects and sizes of available films and the conditions under which they might be borrowed or hired. The same request applies to sets of lantern slides on any model or interesting engineering subjects. We will then compile a register of such services as are available, and are sure this would be of great assistance to club lecturers and secretaries. We should be pleased also to have any information from clubs who have been able to obtain service of this kind from industrial and other concerns, stating the nature and source of the assistance they have received.

Our Shop Window

● VISITORS TO Great Queen Street will have noticed that we have been using the extensive window space available at our premises at No. 16 for the display of several very interesting models. We propose to continue these displays, changing the exhibits from time to time, so that our window will become a Model Engineer Exhibition in miniature. Some of our "M.E." friends have very kindly assisted us in this plan with the loan of some notable and very interesting models, and we shall much appreciate offers of similar exhibits on loan for display at frequent intervals. Apart from the interest to passers-by, which these models arouse, they will give an opportunity to regular readers to see some of the examples of work which figure in our pages, and are naturally of much greater interest in the "solid flesh" than they can be in a photograph. Our previous display at our former offices in Kingsway was regarded as one of the most attractive shop windows in London, and invariably attracted a crowd. Many years ago when we occupied a building in Farringdon Street we had a fine museum of working models in our window, but these proved such a magnet to the passing throng that the police asked us not to have the models shown at work because of the crowd which collected as soon as the current was switched on. We do not propose to show working models at No. 16 Great Queen Street, but there will always be something worth looking at, and something to show the public the clever work of which our readers are capable. When you are in town, do not forget to have a look at the "M.E." window.

An East Lothian Society

● ANOTHER NEW society has been launched across the border. This is for East Lothian enthusiasts, with headquarters at Haddington, the county town. The opening meeting was held at the Unionist Committee Rooms in Market Street on January 10th, and already a number of members have been enrolled. Local readers should get into touch with Mr. George McDonald, "Beechwood," High Street, Gifford, Haddington.

The L.M.S. No. 10,000

● I HAVE been smoking a contemplative pipe over an illustration of the L.M.S. new locomotive No. 10,000, a diesel-electric engine of a type to be introduced to the main line passenger and freight services. Giving the Company all due credit for a notable technical departure in railway traction, I have been trying to anticipate its effect on locomotive modelling. It will undoubtedly arouse much interest in the model railway world, and as an up-to-date prototype for small-scale lay-outs will no doubt find favour. But what will the many steam locomotive lovers think of it? The word "locomotive" conjures up in their minds a vision of a boiler, a funnel, a cab, and perhaps a dome and a safety-valve, to say nothing of driving wheels, a coupling-rod, and valve motion. In fact, a picture of a different animal altogether, and I am sure I can say a much-loved vision with innumerable pleasing associations. The steam locomotive as we see it on the railways may be on the verge of disappearance, but it will long have a place in the affections of all model engineers, and will long continue to emerge from their workshops in miniature to recapture its old glories.

The King of the Workshop

● THE MODEL ENGINEER is truly a king in his own workshop. He can order what is to be made, how it is to be made, and what is to be done with his production when it is at last completed. How different this is from the position of many a skilled mechanic in the factory. He has one specific part, or a repetition of parts to make or machine, and when the job is done it passes from his ken, he may never see it again or know what happens to it when it leaves his lathe or bench. In a large factory he may not even know what part his work plays in the operation of the finished machine or engine for the production of which his firm is responsible. He has, in fact, a rather dull and monotonous bread-winning job governed only by a blueprint and a timesheet. How different is the case of the model engineer building a locomotive, or a beam engine, or any one of the thousand other attractions of the home workshop. Each part he makes has a definite place in a well-conceived whole. He knows where it is to go and what it has to do. He has the pleasure of assembling all the parts he has made and seeing them go into place accurately and effectively, each part a minor triumph in itself, and, collectively, a source of lasting interest and gratification. I think this is one of the main pleasures of the home workshop, the opportunity to see a job right through from start to finish, and to feel that each and every part has been the product of one's own skill. So I think I am right in calling the model engineer the king of the workshop, he is all-powerful in his own domain. Long may he reign!

To My Correspondents

● LETTERS OF congratulation on our fiftieth anniversary have continued to reach me daily, too numerous to publish in full, but all full of the most kindly appreciation and good wishes. A pleasing feature of this correspondence has been the letters from old friends whose names and articles have been missing from our pages for some time past, but who are still keenly interested in our doings. There is for example "Old Gaumless" who writes me in the broadest Yorkshire—or is it Lancashire?—dialect, to say that in the years to come, when he has passed over, if the "M.E." is not "still knockin'abaht an as threng as ivver" he will haunt the workshop of the future and peer through the windows to see what is going on. Before that time comes I hope we shall see his practical pen at work again in our columns. Then there is Mr. Herbert J. Dyer, that master mechanic of Mousehole, who writes:—"I cannot put into words the intense pleasure the vast amount of mechanical hints contained in its pages has given me." My thanks to everybody for their kind words.

Percival Marshall

A One Minute Transformation

A Cabinet Workshop with a Difference

by C. R. Jones

THE time is seven-thirty, and in the corner can be seen what is apparently just a cabinet with cupboard doors and six drawers. On the top is a photograph and another small nest of drawers.

By seven-thirty-one a transformation has taken place, now the cupboard doors have been opened and folded back, disclosing a foot motor and treadle, also a 3-in. screwcutting lathe has appeared on the top of the (now) workbench, and all is ready for an evening's work.

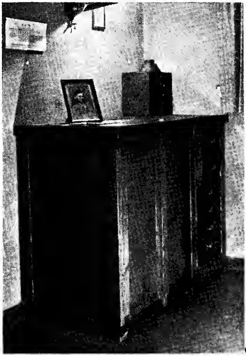
Where the photograph was, a handle can be seen projecting, the turning of which has been the means of bringing the lathe to light from the interior of the cabinet, where it had been resting.

There have been several cabinet workshops described in THE MODEL ENGINEER at various times, but it has always seemed to the writer, that as one is not *always* wanting to use the lathe, the space occupied by it on top of the bench, when it was not required, would be useful for the general work of fitting, assembly, soldering, etc.

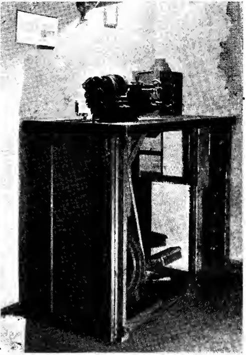
Another point is that with the lathe permanently on the bench top, a somewhat bulky covering has to be made to keep it clean and out of sight, when not in use.

With the present arrangement, the cabinet workshop normally has a flat top and can be used for either fitting or turning at will, the floor space occupied by it being only 2 ft. by 4 ft., and the height 37 in. This cabinet workshop was made during the winter of 1946, and was designed for three main reasons.

In the first place, the lathe had been housed in the usual outdoor workshop, and the summer (so called) of that year being exceptionally wet, it occasioned many a headache trying to keep the lathe reasonably free from rust: the fuel position being so acute, the heating problem looked like being a real one; also, one member of the household out in the shed, and one indoors, evening after evening, tends to be boring, particularly for the one indoors, to say nothing of the discomfort of the other, trying to work in a cold shed in the winter.



Seven-thirty p.m.



Seven-thirty-one p.m.

Of course, not the least of other difficulties was to bring the household authority round to the right frame of mind to agree to the lathe being brought into the house, and the right moment to broach such a delicate subject was very necessary.

Perhaps the psychological moment to point out the advantage of having company of an evening, and the saving in fuel and light, etc., should have been when one had remembered some important anniversary, or had located where to obtain the latest in "nylons"; who knows?

Anyway, the necessary agreement being reached, the thing to do was to get materials for the project, and this looked like being the most difficult problem of all.

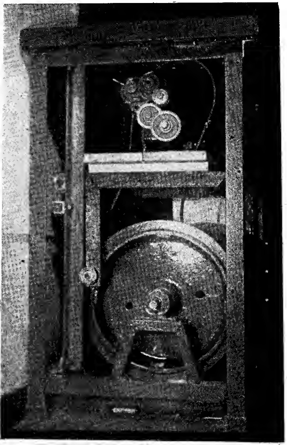
It was at first thought best to make it almost entirely of wood, as that seemed to be the most suitable material to use, but enquiries at various sources of (short) supply very soon dispelled this idea, and other materials had to be sought.

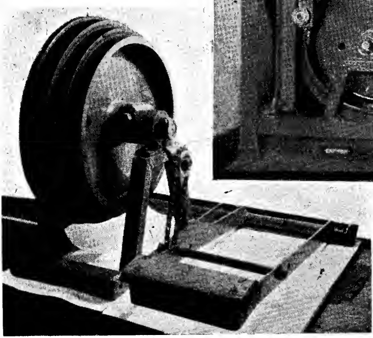
After much searching around, eight lengths of old bedstead angle were obtained, so a design was eventually got out to incorporate these in the main construction.

As the original lathe drive was by a countershaft on the bench at the rear of the lathe, which was driven by a belt from a heavy flywheel, having one step only (see "M.E.", dated August 13th, 1942), and which ran on a spindle attached to the left-hand iron standard supporting the bench and lathe, it will be realised after a little consideration, having regard to pulley positions, etc., that this would be of no use in the present arrangement.

Curiously enough, just about that time, the chance came to acquire a heavy three-speed flywheel, with the largest diameter of about 16 in. So the first thing constructed was the foot-motor shown in the photograph, No. 3.

An angle-iron framework of $1\frac{1}{2}$-in. $\times$ 3/16-in. material was made up for the base, and two tapered supports of 1-in. "U" section iron were welded to this. A spindle was turned up to fit the flywheel, and two discarded double-row ball-bearings were used to support wheel and spindle. These were fitted in housings made up from 1-in. $\times$ $\frac{1}{8}$-in. flat-iron, welded into





Left—Photo No. 3. View showing completed foot-motor

Above — Photo No. 4. End view of lifting gear with end panel removed

circular shape, and on to pieces of 1-in. × ¼-in. iron to act as bolting-down feet.

A cover of sheet-metal was welded to one side of these housings, and large washers were fitted on the shaft to keep the other sides dustproof.

A crank was made out of an old car brake arm, and this had a 9/16-in. bolt welded on to form a crankpin. This pin was fitted with another ball-cast-iron ends had the dovetail parts knocked off with a hammer, and were then ground off flat on an emery wheel (it was found that they were too hard to file) and these formed the feet.

Two shorter lengths were then welded across each pair of legs, one at the top and one near the bottom. See photograph No. 4.

This formed the framework for each end of

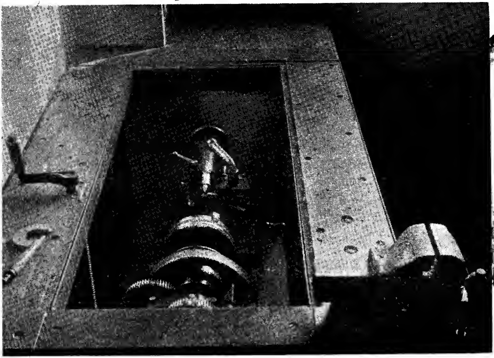


Photo No. 5. View from top with cover removed, showing lathe in the down position

bearing which was sweated inside the inner ring from another larger race.

The groove in this ring was just wide enough to take a cycle chain, which acts as a connecting-rod and is anchored to a hardened collar attached by means of a long bolt and a length of tubing to the treadle. This was made from 1½-in. × 3/16-in. flat-iron, bent round "U" shape and welded to a piece of stout steel tubing, which in turn runs on a length of 9/16 in. diameter mild-steel, suitably supported at the rear of foot motor.

This foot-motor runs very freely and with very little effort, and is clearly shown in the photographs.

Having completed the foot-motor, a start was made on the bench or cabinet, and although the bedstead angle was the only material to hand at the time, it was hoped that other odd bits and pieces could be picked up as the job progressed, which later proved to be the case.

The first things made were the two main supports for the bench top, and for these the two strongest pieces of angle were used. These were cut in halves in the first place, and the bench and the size of each frame was 35 in. high and 20 in. wide.

The back was braced by means of a cross-piece made of ¾-in. electric conduit, welded at the crossing point, flattened at the ends, and bolted to the top and bottom of rear legs.

Another piece of angle was bolted at the rear of framework and was the full length of bench. This rested at each end on the bottom cross-pieces of the main supports.

The top was then taken in hand and a framework welded up from the angle, 4 ft. long and 22 in. wide. This was like a large picture frame with the rebate at the top.

Four other pieces of angle were welded inside this, leaving an opening in the correct position 2 ft. 6 in. × 12 in., and this was for the lathe to come up through.

When the top framework was complete, it was decided to start erecting the cabinet in the corner it was to occupy, as it was obvious that the whole thing was going to be quite heavy when it was complete, so the top was bolted on to the end supports and the back cross-strut bolted into position.

It will be realised that the top framework consisted, in effect, of an opening with a channel all the way round, and this channel was carefully filled in with wood $1\frac{3}{4}$ in. in thickness, which had been obtained in the meantime and was pre-war stuff.

It was drilled and countersunk and secured to the angle by means of $\frac{1}{4}$-in. B.S.F. countersunk setscrews, for which the underside of the angle had been drilled and suitably tapped. See photograph No. 5.

The top was now complete and it looked rather a gaunt structure, and somewhat top-heavy, and several hints were received that it would be a good job when the sides were filled in. So taking the hint, the panelled portions were tackled next, and some 1-in. boarding was cut into strips 2 in. wide and grooved for panels, by means of a home-made treadle, circular saw bench, which had been made some years previously.

These strips were cut to suitable lengths and

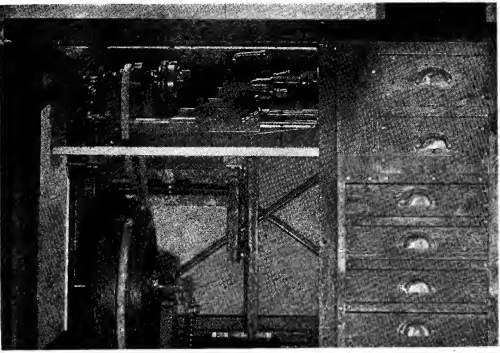


Photo No. 6. View from front, showing lathe in the down position

joined together at the corners by means of glue and screws, the upright portions being halved, and as some secondhand pieces of Masonite boarding 3/16 in. thick had been obtained, this was used for the panels.

About 2 ft. 4 in. along the front of the structure another leg was made and fixed, and was connected up at the lower end to the angle-iron previously mentioned, running at the rear lengthwise, by a piece of angle-iron bolted on at the same height. See photograph No. 6.

As this cabinet fits in a corner, and owing to shortage of materials, only the two sides that show are filled in, and as can be seen by the photographs, one panel fills in the left-hand end, and the door covering the foot-motor and treadle is divided into two parts, hinged together at the centre, the hinges being at the back so that when the doors are opened the inside surfaces go together.

To fill in the opening in bench top when the lathe was not in use, a wooden cover was made from 1-in. material with suitable braces, and an iron frame was made from $1\frac{1}{4}$-in. $\times$ $\frac{1}{8}$-in. flat stuff, mitred and welded at the corners, and this was made large enough to overhang the cover about half an inch all round, and was bolted on to it with about two dozen $\frac{1}{4}$-in. countersunk setscrews and nuts with flat washers underneath. To accommodate the overhanging portion of the iron a rebate $\frac{1}{2}$ in. wide and $\frac{1}{8}$ in. deep had been cut in the top inner edge of the wood filling in the top frame, and this can be seen in photograph No. 5.

The space inside the iron frame on cover, was filled in with a piece of linoleum to bring all flush with the bench top when cover was in position.

To fix cover, two ordinary cupboard bolts were screwed to the underside, and suitable holes were drilled into the angle-iron surrounding the opening to receive them.

(To be continued)

IN THE WORKSHOP

by "Duplex"

2—Spotfacing and Counterboring

WHEN machine parts are held together by bolts, studs and nuts, or screws, it is essential that certain mechanical principles should be observed if satisfactory work is to result. Although in rough-and-ready engineering practice it is quite usual to bed nuts and bolt-heads on unmachined surfaces, and in the case of the family mangle this may arouse no comment, such practices are quite inexcusable when applied to the working parts of machine tools. When, therefore, you are choosing new equipment for the workshop bear this in mind, for attention to such points betokens, in this respect at least, proper care in design and manufacture. As an example of the correct method, Fig. 1 shows a component secured by means of a nut and washer engaging a screwed stud. It will be evident that, if the upper surface of the bolting boss is not at right-angles to the stud, not only will the end of the stud be bent when the nut is tightened, but the work of tightening the nut will in part be expended in bending the stud, and a false estimate of its security may be formed.

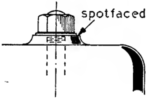


Fig. 1

Fig. 2

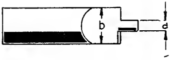


Fig. 3

To overcome these difficulties, the surface of the bolting face must always be truly machined at right-angles to the long axis of the stud. This machining operation will be facilitated if bolting-bosses are provided, so that only these small areas have to be machined and not the whole upper surface of the component.

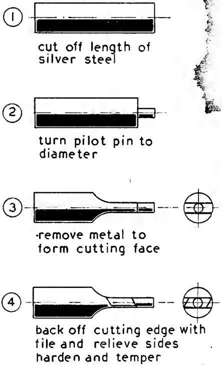


Fig. 4

A milling or turning operation may be used to machine a number of bosses on a component at a single setting, and what is more, they will then all be of equal height from the base.

Spotface Cutters

On the other hand, it may be found more convenient to face these bosses one at a time in the drilling-machine, and equal height can then be maintained by using the drilling-machine depthing stop.

The tool commonly used for the purpose is the spotface cutter depicted in Fig. 2. As will be seen, this cutter has a guide pin and four cutting edges; the guide pin should be a running fit in the previously drilled bolt hole, and the diameter

of the cutter should be sufficient to machine the upper surface of the bolting-boss to afford a seating for the washer. In the small workshop, however, the two-edged cutter shown in Fig. 3 has the advantages that it can easily be made to any size required, and can readily be resharpened when it becomes blunted.

The stages in making one of these cutters are set out in Fig. 4.

Counterboring

When, as illustrated in Fig. 5, a screw clearance hole is bored out to accommodate the head of a

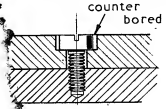


Fig. 5

cheese-headed screw, the operation can be carried out conveniently by means of a counterbore. This tool is the same as the spotface cutter, but in this case the cutter's outside diameter must be of a size to afford the correct clearance for the screw-head. In high-class mechanical work, only screws with the head truly concentric with the screwed portion are used, and it will be found that, for the sake of good appearance, the screw-head is given very little clearance in the counter-bored recess.

When a counterbore is used in the drilling-machine, the depthing-stop should be carefully set, to ensure that the screw-heads will lie flush with the surface of the work when the components are finally assembled.

As an alternative method of recessing the work for the screw-heads, the clearance hole is opened out with a drill of the correct size, and this is followed by an end-mill that fits this hole ; the drilling-machine depthing-stop is set to allow the end-mill to enter the correct distance, and so form a flat surface at the bottom of the recess.

It will be found that screws with rolled threads sometimes have roughly-formed heads, which may or may not be concentric with the screwed portion, and in consequence it may be difficult to seat these screws neatly and accurately in the work.

In the case of instrument and other high-quality work, it is often an advantage to make the screws specially to suit the work in hand, and if, for example, a head diameter of $\frac{1}{4}$ in. is chosen, it is an easy matter to recess the heads either by counterboring or by using a $\frac{1}{4}$-in. diameter drill, followed by a $\frac{1}{4}$-in. end-mill.

To revert to the design of spotface cutters and counterbores—as has already been pointed out, these may be of the commercial type with four cutting edges, or as made in the workshop with two cutting lips only.

The commercial cutters up to $\frac{1}{2}$-in. diameter are generally made with the guide pins integral with the body, but above this size they can be obtained with both interchangeable cutter-heads and pins. When cutters are made of the form shown in Fig. 3, the diameter (*a*) should be made either equal to that of the stud clearance hole or of the tapping size hole as may be required, and the diameter (*b*) should allow clearance for the screw-head, or for a washer when a portion only of a surface is machined. When large size counter-bores are required, they are best made as illustrated in Fig. 6 with a shank to carry both interchangeable cutter-heads and pilot pins. The cutter itself should be provided with a grub-screw engaging a recess in the shank to prevent rotation

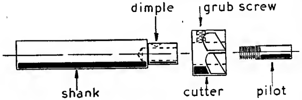


Fig. 6

while in operation, or, alternatively, the cutter can be made to screw on to the shank as in the case of the pilot pin. In this way, a combination of the correct size of cutter and guide to suit any particular job can readily be obtained.

Practical Examples

Those who were interested in the construction of the MODEL ENGINEER Road Roller may remember that the steering fork was attached to the front roller frame brackets by two $\frac{1}{4}$-in. pivot bolts, and that, to ensure free working, it was necessary to face the fork bearing bosses on both their inner and outer surfaces.

The method adopted to carry this out was first to drill and ream the fork bearing holes in line, and then to spotface both ends of the bores. For this purpose a cutter-head $\frac{5}{8}$ in. in diameter and with a $\frac{1}{4}$-in. bore was made similar to that shown in Fig. 6, except that it was $\frac{3}{4}$ in. in length to prevent wobble on the shank, and was held by two Allen grub-screws. The shank used was a straight piece of $\frac{1}{4}$-in. silver-steel of a length sufficient to give a grip in the drilling machine chuck as well as holding the cutter and providing a bearing in *both* the fork bearings. With the cutter mounted in the drilling machine, as shown diagrammatically in Fig. 7, and the fork clamped to an angle-plate secured to the machine table, the upper face of one fork end was faced.

The cutter was then transferred to a position between the fork ends and the inside face of the other fork end was machined. The fork was now reversed on the angle-plate and these operations were repeated to complete the machining of the bearing faces.

Turning again to the subject of recessing screw-heads, the writer recently came across a lathe in which the keep plate of the saddle top slide, that is to say the fitting which takes the push and pull of the feed screw, was secured by two cheese-headed screws which stood out unashamedly and bedded against the rough-cast

surface of the component. Moreover, it was found on examination that the clearance holes for these screws were 20 thousandths of an inch oversize, in order to allow the keep-plate to be lined up with the feed nut during assembly. It so happened that this keep-plate had to be removed from time to time when lever operation of the slide was required, and considerable time was wasted when the plate had to be replaced and again lined up, particularly as the rough surface of the casting caused the keep plate to wander as the screws were tightened. To overcome these take the heads of the new screws, and the third screw was fitted in the same way, where it could best secure the keep-plate against the thrust of the feed screw.

As a result of this work the keep-plate can be removed and quickly replaced in correct alignment, and at the same time the appearance of the top slide is greatly improved and is no longer an engineering eyesore for the fastidious.

An alternative and effective method of fitting register pegs is to use standard taper pins, fitted with the aid of a standard taper pin reamer. One

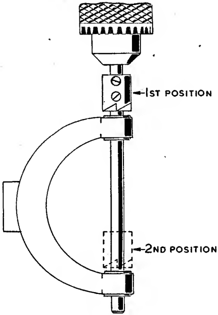


Fig. 7

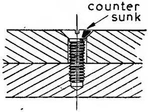


Fig. 8

Fig. 9

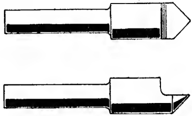


Fig. 10

difficulties, the keep-plate was accurately lined up and firmly secured in place by its screws ; the top slide was then mounted vertically in the drilling machine, and two well-spaced holes were drilled with a No. 31 drill through the plate and for a distance of some $\frac{3}{4}$ in. into the top slide casting. The keep-plate was then removed and the holes in the casting were enlarged with a $\frac{1}{8}$-in. reamer to take two turned $\frac{1}{8}$-in. register pegs a firm sliding fit.

The next operation was to secure these pegs in the keep-plate ; and this was done by entering the reamer on the *inner* or abutment face of the plate, until under finger pressure the pegs reached to within $\frac{1}{8}$ in. of the outer face. The pegs were then pressed into position in the vice with their outer ends flush, and leaving some $\frac{1}{4}$ in. projecting inwards to engage the body of the top slide.

The two original $\frac{3}{16}$-in. rolled thread screws were discarded and three new screws with $\frac{5}{16}$-in. concentric heads were machined. The original screw clearance holes were then counterbored to

or more deep holes are drilled with the component secured in place, and these holes are reamed until the pins enter to a sufficient depth.

The parts are then separated and the taper pins are secured in the outer component by pressing in the vice.

The inner holes are then carefully reamed until the parts can again be brought into close contact by the application of light hand pressure. This method has the merit of allowing the pins to be readily refitted in either component to compensate for wear.

When, as depicted in Fig. 5, a component has to be accurately located, either the methods of using register pegs, just described, can be used, or the screws themselves, as is often the case, are made to serve this purpose. If the latter method is to be effective, an unthreaded parallel portion of the shank of the screw should fit accurately in a reamed hole in the outer component, and the head should be given slight clearance in its recess.

Countersinks

It is good practice whenever possible to use cheese-headed screws for securing and locating components, in the manner already described, but screws with countersunk heads are often used for the purpose, either when necessitated by the thinness of the material or to reduce manufacturing costs. Unless screws of this type have a plain parallel portion closely fitting into a

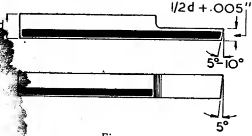


Fig. 11

reamed hole in the work, they should not be used for the positive location of parts ; moreover, it is not at all unusual to find that the heads of these screws are not concentric with the shanks, which is an additional factor often causing inaccuracy when assembling components. Screws fitted as illustrated in Fig. 8 cannot be relied on to maintain the location .of parts such as indexing mechanisms, where stability is of extreme importance ; but if, in addition, register pegs are fitted, this form of attachment should be effective. Countersunk screws are usually made with heads of 90 deg. included angle, and the appropriate countersinking tools usually have this angle slightly reduced, to ensure that the screw-heads make close contact with the work at their upper ends. A commercial form of machine countersink is illustrated in Fig. 9.

These countersinks must be run at moderate speeds and should be held firmly in contact with the work, otherwise they tend to chatter, and to cut a multi-sided pyramid rather than a true inverted cone.

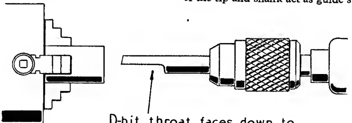


Fig. 13

In the event of chatter developing, reduce the machine speed and clamp the work firmly to the machine table.

The countersink illustrated in Fig. 10 will overcome these difficulties, as it has but one cutting edge and one non-cutting guide surface ; furthermore, this tool has the advantages that it is easily made in the workshop and can be readily sharpened when required, whereas it is difficult to resharpen the five-sided variety satisfactorily by hand.

D-bits

As these tools are akin in many respects to the foregoing, it may be opportune here to described the method of making them, and their use in the workshop to drill really accurate holes. But first some practical observations on drilling in general.

It might be thought that a twist drill would bore a perfectly true, straight hole to the full extent of its length, but unfortunately that is not the case ; for these drills, as one would expect from their construction, have but little rigidity to withstand

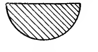


Fig. 12A

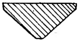


Fig. 12B

bending stresses, and any slight irregularity of the cutting edges will cause the point to wander in an increasing degree, as the feed pressure is applied, and the drill is thereby distorted. Again, if the drill encounters hard or soft spots in the work, the point will tend to wander and the axis of the drilled hole will deviate from the straight line intended.

Deep holes are often drilled with the work secured in the lathe chuck and the drill held in the tailstock chuck and although this method of drilling with the work revolving and the drill stationary promotes accuracy, this is seldom attained with ordinary drills. Hence, if straight drilling is at any time essential, support must be given to the drill tip when in operation. This is best ensured by using a D-bit, so called from the shape of a section of the cutting portion which resembles the letter D.

The usual form of this drill is depicted in Fig. 11, and it will be apparent that a single lip performs the actual cutting, and the remainder of the tip and shank act as guide surfaces. In the smaller sizes up to some $\frac{5}{16}$ in. diameter the section is as shown in Fig. 12A, but sometimes in the larger sizes the sides of the bit are relieved, as in Fig. 12B, for a distance equal to the length of the D portion ; this lessens the rubbing area at the point and forms an additional space in which the chips can collect.

(*Continued on page* 66)

Admiralty Research and Development

A VAST amount of fundamental scientific work has been accomplished by British Admiralty establishments during the past decade and a very large amount of work is envisaged for the future in order to keep the Royal Navy in the first rank of efficiency.

Many lines of enquiry present themselves for patient and exacting investigation. On the defensive side, the Navy has to apply the lessons learned by its observers of the Bikini tests of the atomic bomb, but the implications of atomic energy are, in the long view of the naval situation, by no means limited to defensive aspects and may, contrary to initial reactions, lead to an enhancement of naval power in a highly modified form and with wide offensive and defensive commitments. The atomically-propelled warship, for instance, would have no immediate refuelling problems and the period for which it could stay at sea would be limited only by other and generally less urgent supply problems, a vital factor if the ship proved less vulnerable than the harbour. Again, a revolution in naval ordnance, in the light of the guided rocket missile, opens a field in which research is essential to security. The Navy's commitments, which already include the convoying of food across the oceans, may even extend to assisting the discharge of cargoes on coastlines where ports are desolated, the Mulberry principle in defence. Side by side with these long-term problems are the immediate and mundane questions on all the intricate detail of keeping ships at sea and flying aircraft from ships.

More than six million pounds was the estimated expenditure by the Admiralty on naval research and development during the past year. Owing to the very large variety of naval technical requirements, the allocation of this sum had to be carefully considered, but, as the First Lord of the Admiralty, Viscount Hall, said in presenting the estimates, " within the limits of the resources available, priority continues to be given to the work of scientific research, and steady progress is being made in the building up of the Royal Naval Scientific Service."

Old-established Departments

While much of the fundamental research is undertaken by members of the R.N.S.S., recruited from the Universities and from among industrial specialists of proved reputation, a large contribution is made by members of old-established departments, such as the Royal Corps of Naval Constructors, who design ships, the Engineer-in-Chief of the Fleet, who powers them and the Director of Electrical Equipment. These technical departments are co-ordinated by the Controller of the Navy, who is the Third Sea Lord and who is responsible for the supply of all material to the Navy. A most important feature of the organisation is the employment ashore, for periods of two or more years, of Naval Officers who have served afloat in both the executive and technical branches of the Royal Navy. It may be confidently asserted that this feature was one of those which led to British naval material proving superior in quality to that of the Germans. Enquiries conducted at the conclusion of hostilities, showed that, while an immense and imaginative effort had been made by German scientists, much of the German equipment lacked the robust features and operational simplicity which was a virtue of the British material—the hall-mark of the man with sea experience.

Data and prototypes which would be outside the scope of commercial concerns emerge from some of the Admiralty establishments and many naval scientific investigations have commercial byproducts. It is possible to instance the development of new and economical furnace technique for the burning of heavy fuels for the production of power, the use of steam machinery of high temperature and pressure conditions, aspects of gas turbine and oil engine design, improved navigational aids and the development of fire-resistant materials, all of which have direct or indirect bearing on mercantile practice.

Wide Field of Research

It is almost impossible for a single mind to grasp the nature of all the problems involved and it is certainly impossible to give detail in any simple form. All that can be done is to enumerate the institutions and to give a brief but inadequate clue to the kind of work which they undertake.

For a start, there is the rather generalised work of the *Admiralty Research Laboratory*, under the Director of Physical Research. It deals with all subjects upon which fundamental research is needed other than those studied in the more specialised works and laboratories. The subjects in which experiments are made in this laboratory include acoustics, aeronautics, oceanography, under-water ballistics, instrument making, photography, camouflage, luminescence and such matters as the packing materials for various kinds of equipment and stores.

Another maid of all work, the *Admiralty Chemical Department*, founded in 1870, deals with general chemical problems for various departments, dockyards and depots. The field includes explosives, food, paints, anti-fouling compositions, lubricating oils and greases, rubber, plastics, toxic gases liable to be encountered in ships, insecticides, fireproofing, insulating materials and boiler and evaporator water problems, including anti-corrosion methods.

The Admiralty Experimental Works and the *Naval Construction Research Establishment* both deal with physical problems such as are encountered by the Director of Naval Construction. The first is largely concerned with experiments on a comparatively small scale in water tanks, while the latter organises large-scale experiments at sea. At the works there are tanks for testing the effects of various ship shapes passing through the water, cavitation tunnels for propeller research, apparatus for testing the effects of vibration and shock and tanks for testing steering gear. The Research

Establishment has its own floating laboratory, H.M.S. *Barfoot*, a former boom defence vessel, but the work is much too broad to be carried out from a single ship and experiments are made off shore with a variety of targets, some specially constructed to simulate sections of new ships and some consisting of old and redundant ships. Both types are used in assessing the effects of weapons on warships, and these effects are accurately studied with elaborate measuring instruments.

The specifically engineering researches of the Royal Navy are conducted at the *Admiralty Engineering Laboratory*, where work on gas turbine development is among the projects in hand. At this laboratory the internal combustion engine for submarines was pioneered and various gearing problems are studied.

In matters of chemistry both the Director of Naval Construction and the Engineer-in-Chief of the Fleet consult the Chemical Department or one of the two laboratories dealing with metallurgy. First of these, the *Admiralty Central Metallurgical Laboratory*, deals with foundry processes, welding and jointing, fabrication methods, heat treatments, metal cleaning and machining problems. It also is concerned with those aspects of marine biology which bear on the diagnosis of the cause of corrosion in boilers and other equipment. Work in *The Bragg Laboratory* is largely devoted to safeguarding the quality of materials used in the building of warships and advising on the types of materials, their treatment and methods of inspection.

The *Admiralty Fuel Experimental Station* has made major contributions to the important task of obtaining the maximum work from the fuel burned in ship furnaces. Among other undertakings the Station has developed an entirely new furnace front in which impinging jets produce a swirling ball of fire at the centre of the furnace. Not only is heat saved, but less soot is deposited on the furnace walls. Means of making black smoke for tactical purposes are also studied at the Station.

Improvements of Electrical Gear

Improvements in the design and performance of all kinds of electrical gear, including switchgear, batteries, cables, fuses, lamps, logs and other recording instruments are the province of the *Admiralty Engineering Laboratory (Electrical Department)*. A major commitment at this laboratory is submarine equipment, a great proportion of which is electrical.

Both the radar and radio aspects of electricity are studied at the *Admiralty Signals Establishment*, which is the largest of all naval research institutions. Since the early days of naval warfare, communications have been vital and, to-day, a flagship must incorporate a nerve centre which is in many ways more complex and more rapid in reflex than a post office ashore. Radar has expanded with mushroom rapidity. Originally a means of locating enemy aircraft. it now embraces the location of enemy ships, navigational aids and has become virtually a component in naval ordnance and ammunition.

The *Service Electronics Research Laboratory*, a new addition to the combined service research facilities, is under Admiralty direction. It is concerned with research on short-wave valves and the pursuit of those lines of enquiry inspired by the British discovery of the magnetron, which is fundamental to radar development.

The *Admiralty Compass Department* has its mercantile associations. The department devotes its energies to the development of magnetic and electrical navigational aids. It has produced equipment varying from large binnacles to small compasses for landing craft. During the recent war, it assisted the Army by designing compasses for station keeping by flail and other tanks which might be invisible to each other even during the day. Gyro-inductor compasses were also designed for aircraft during the war and, to-day, various improvements in the gyro-compass are under consideration.

The *Craft and Amphibious Material Department* came into existence to deal with requirements for all kinds of curious marine monsters and its products belie any idea that the naval mind is incapable of the unorthodox. Its projects have varied from tiny silent-approach electrical canoes to large floating airfields.

Weapons and Antidotes

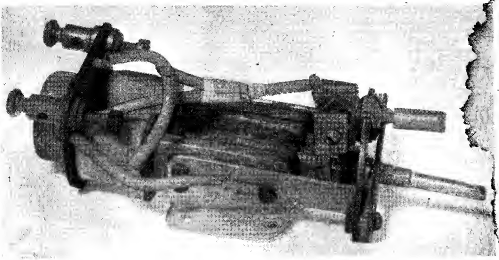
The institutions so far described cover most of the range of marine requirements, but not the problems concerning specific weapons and their antidotes. The detailed study of these problems lies with the *Naval Ordnance Department*, the *Torpedo Experimental Establishment*, the *Mine Design Department* and the *Anti-Submarine Experimental Station*. Each of these establishments has a wide field of its own, involving physical and chemical questions, which may in part be referred to the more general laboratories but which inevitably call for detailed and specialised experiments. The Ordnance Department, which copes with everything from 16-in. hydraulic gun mountings to minute electrical and optical equipment for laying and ranging, now has experiments with rocket missiles added to its commitments. To the large variety of propulsion devices and warheads in torpedo work, came the additional problem of homing devices. Magnetic and acoustic mines, mines laid from the sea and the air, widen the range both offensive and defensive of this once simple method of waging war at sea.

In addition to the material problems, to which there are scientific answers, there are medical, psychological and dental problems. In every sphere there is need for co-ordination and cross reference. For instance, the habitability of ships is primarily a matter for the constructor, but it has its engineering and its medical aspects. All the scientific work is co-ordinated by the Chief of the Royal Naval Scientific Service and the three small groups of scientific administrators directly under him. He is responsible for considering inventions and suggestions made by the public which, at one peak period during the recent war, averaged no less than a thousand a day.

A Simple Marine Motor

by G. E. C. Webb

THE simple little electric motor shown in the photographs was made during the war, when I was away from home and in lodgings. No lathe was available and the whole job had to be carried out with such small hand-tools as I could carry about with me in an attaché case.



View of motor, showing armature, commutator and brush gear, approximately full size

The field magnet was sawn and filed from a piece of galvanised iron pipe, the top end being filled with a disc sawn and filed from a piece of soft iron bar. It was made a light driving fit in the end of the piece of pipe. Then holes were drilled, countersunk and tapped through the wall of the pipe and into the iron, after which four steel screws were screwed in, cut off and riveted over, and then filed flush. The armature laminations were cut from an odd piece of corrugated iron sheet, which was first flattened out and left in the kitchen fire one night when the household went to bed. When it was taken out the following morning, it was found to be beautifully soft and all the zinc coating had burned away. Thirty laminations were made and this number of circles were first cut, slightly oversize, and a hole drilled in the centre of each through which a bolt was passed. When they were all on the bolt, they were clamped together with a nut and the end of the bolt was chucked in a hand brace which was held in a vice. The services of an interested small boy were enlisted to turn the handle while I operated on the armature with a file until it was " turned " down to the correct size.

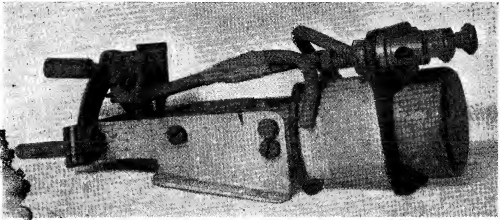
The laminations were then removed from the screw and pushed one by one on a piece of Meccano rod to serve as an armature shaft, each being separated from the next by a thin piece of paper soaked in candle grease.

The commutator was made from an ebonite bush, taken from an old wireless condenser. This already had a cylinder of brass screwed on it, and all I had to do to convert it into a barrel commutator was to divide the brass bush into three equal parts. This was accomplished by cutting a fibre ring which was forced on to one end of the brass cylinder. The other end was then cut in three places with a miniature hacksaw, after which the fibre ring was pushed down to the cut end. Then three cuts were made in the other end of the cylinder and continued until they met the slots first made. The fibre ring was left at one end to hold the three pieces of brass in place.

The brass bearings at each end were made from odd pieces of sheet and tube. The tube was a lucky find, for it fitted the armature shaft like a glove.

The side plates were cut from the aluminium panels of a crashed motor car and the brass semi-circle at the commutator end was cut from another piece of the wireless condenser. It carries the holder for the brushes, which can be slid along it for adjustment and clamped in position with a six B.A. screw. The brushes are of hard shim brass, insulated in their holder by washers of cardboard, soaked in candle grease. The ends of the field coils are of thicker cardboard and one of them is made big enough to serve as a terminal board.

The armature and field were wound with



Side view of the motor, approximately full size, showing the method of making the field magnet from iron pipe

lacquered wire from the coil of a wireless crystal set of great antiquity. This wire, which was about 32 gauge, was all there was available at the time, and as much as could be conveniently wound on was used. The two field coils were connected in parallel with each other, the whole field being in series with the armature. All the connecting wires lead through bicycle valve tubing.

The little motor runs well on six volts, supplied by two cycle lamp batteries. It has been put away in a cupboard for quite a long time now, but I hope to build a hull for it to drive one of these days.

In the Workshop

(*Continued from page* 62)

In some of the larger commercial D-bits an axial oil-channel is provided to allow lubricants to be forced to the cutting edge, but, unless a cutting fluid is used with this form of bit, the chips are apt to collect in the groove and cause jambing.

It will be apparent that a tool of this form, if started truly, will continue to cut in a straight line, for it has adequate guide surfaces right up to the tip, and, as there are no side cutting edges, it cannot bore a hole larger than its own diameter. Furthermore, it has no tendency to dig into the work, and the cylindrical portion is not weakened by flutes or flats.

In theory, the upper surface of the cutting edge should lie on the diameter, but in practice this edge is formed a little above the line of the diameter to allow of sharpening with a handstone ; apart from this, the tool should be sharpened solely by grinding the front face.

To use a D-bit it is advisable, in the larger diameters at any rate, to remove the bulk of the metal with an ordinary twist drill, leaving some $\frac{1}{8}$ in. for the final operation. To start the D-bit truly and to afford it proper guidance from the outset, this pilot hole is enlarged with a boring tool, until the bit enters a good sliding fit for a distance of at least twice its diameter. Drilling can then be carried out in the ordinary way with the D-bit mounted in the tailstock chuck. As the bit advances deeper into the work it will have to be withdrawn at frequent intervals to clear away the swarf, for the only space in which the chips can collect is that opposite the flattened D portion. It will sometimes be found that the chips can be more easily cleared from the bore if the bit is used in the inverted position as shown in Fig. 13.

A Practical Example

The following machining operation may be cited as an example of the utility of the D-bit, and the high degree of accuracy that can be attained with simple tools. A brass clock pendulum-weight 8 in. in length was mounted in the lathe chuck, and with the aid of a D-bit a $\frac{1}{4}$-in. hole was bored from end to end to accommodate the pendulum rod. The D-bit used was made from a length of silver-steel, suitably hardened and tempered after having been filed to shape ; finally, the cutting edge was carefully sharpened on an oil stone. On completion of the drilling operation, the weight was found to run truly when supported between the lathe centres, and the shank of the bit proved to be a good sliding fit in the bored hole.

Form-cutting Small Gear-wheels

by R. B. T. Hall-Craggs

THE following method is handy for cutting small straight or single-helical spur-gears in the lathe, with a minimum of special equipment. The principle is to use a form-tool, the shape of the tooth-space, in the tool-post with the gear blank held between chuck and back centre, traversing the saddle by the leadscrew handwheel to cut the teeth as on a shaping machine. It is a bit slow to cut steel wheels in this way, but all right with bronze or brass stock.

The first job is to get the form-tool accurately finished, and for this a microscope is needed. The writer used one of 33-to-1 magnification for teeth of about 44 D.P., the range of view being a $\frac{1}{16}$ in. diameter circle, which was just enough to bring the whole formed part of the tool into view.

The magnification was measured by laying two rulers on the microscope table, one under the lens and the other alongside. After focusing the first ruler, both eyes were opened and the second ruler moved till the two appeared to lie alongside each other. A 1/32-in. division on the first ruler then equalled 1 $\frac{1}{32}$ in. on the second, *i.e.* magnified by 33.

An alternative method which is easier for the eyes, but needs a strong light and gives less magnification, is to remove the eyepiece and intermediate lens of the microscope. Then an image can be focused on a piece of ground glass or tracing-paper laid on top of the microscope where the eyepiece should be, making the instrument into a miniature profiloscope.

The tooth-forms were then developed on the drawing-board to a scale of 33 times full-size, using the textbook method for involute teeth, with a pressure angle of 20 deg. First, the shape of straight spur teeth was drawn, then this was narrowed by projection in the ratio of the cosine of the helix angle. This gave the final magnified tooth-form with which the tool point was compared under the microscope in exactly the same way as the two rulers were compared previously.

The tool itself was made of $\frac{3}{8}$-in. round silver-steel, with a flat $\frac{1}{8}$ in. wide filed and honed along it to form the top face, with a guide-line scribed along the centre of the flat. Both ends were used, for forming 25-tooth pinions and 46-tooth wheels respectively, as the tooth-shapes differ appreciably if the gears differ in size by more than two or three teeth.

The tips were filed and stoned to finished shape before hardening, keeping a slight clearance angle on all sides.

A piece of $\frac{1}{2}$-in. by $\frac{1}{2}$-in. square steel bar was drilled lengthwise with a $\frac{3}{8}$-in. hole and slit along one side to make a tool-holder, so that the tool could be set accurately to the helix angle and then gripped very firmly in the tool-post.

Accurate setting of the tool to lathe-centre height is essential. Also, the tool should be set well to the left of the saddle if cutting towards the right, and vice versa, to avoid digging in.

For cutting straight teeth there only remains the indexing of the headstock by rigging a pin to engage in the teeth of a suitable change-wheel on the spindle, taking up backlash by winding a string a couple of times round the chuck and hanging a weight of a pound or two from it down behind the lathe bed. The depth of tooth is gauged by using the cross-slide dial-index. The tool is withdrawn for each return stroke, and the teeth are first of all cut to 0.001 in. less than final depth and then the last thousandth is removed on a second round of cuts. The sequence of cutting should not be straight round the blank, but "stepped back"; i.e. for a 25-tooth wheel, cut in the order 1-2-25-3-24-4-23-etc.

For helical gears, the change-wheels are set up to cut a "screw thread" of pitch = (pitch diameter of gear) $\times \pi \times$ cotangent (helix angle), calculated in the usual way, but remembering :—

(1) The two indexing-wheels must be kept for fitting on the lathe spindle in their turn.

(2) Mating helical gears must be left- and right-hand respectively; mating skew gears (whose axes are at right-angles to each other) are both the same hand.

(3) The helix angle of two mating skew gears must add up accurately to 90 deg.

(4) The same train of gears will be used for mating helical gears of different numbers of teeth, except for the change of the indexing wheel, and, if needed, a change due to the indexing wheel being a different multiple of the number of gear-teeth to be cut with it.

(5) The change-wheels should be calculated, set up and checked before deciding finally the dimensions and angles of the gears to be cut, as pitches will be limited by the wheels available. Quite probably extra wheels will need to be rigged.

After this, the cutting is the same as for straight gears, except the work revolves, as the lathe spindle is driven by the change-wheels from the leadscrew. The indexing is shifted by disengaging the index wheel from its mate by drawing it off the spindle, but no other part of the set-up should be touched while cutting is in progress. All change-wheels should have their teeth cleaned before use.

If several gears of the same size are wanted, they should be cut as one long blank and parted off after cutting, or threaded on a mandrel after turning and boring. In either case, the back centre must be used for rigidity.

The procedure described above takes time, but is an interesting exercise in workshop technique, and can produce good gears.

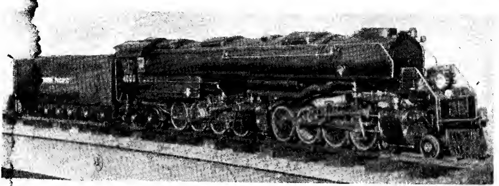
The Biggest $2\frac{1}{2}$-in. Gauge Loco. Yet

by "L.B.S.C."

WHEN that versatile engineer-architect, Mr. Ed. Adams, really gets going, you can bet that the result is going to be something startling—and you'll win! Take a look at the reproduced photographs, and read the following notes, for a typical example.

In the *Railway Gazette* for January 30th, 1942, appeared drawings, photographs and a description of a high-speed 4-8-8-4 articulated freight locomotive built for the Union Pacific Railway of U.S.A.; and when our worthy friend saw them, he immediately caught a dose of the same complaint that your humble servant contracted, way back in July, 1926, when I saw the picture of the U.P. 4-12-2 (there must be something "deadly" attached to the Union Pacific!), and got an irresistible urge to build a $2\frac{1}{2}$-in. gauge edition. Nothing could be done at the moment —a person known as Jerry could tell you why— but in October, 1943, the drawings in the *Railway Gazette* were enlarged to a suitable size for $2\frac{1}{2}$-in. gauge, some details added from the *Locomotive Cyclopedia*, and some letters passed between our good friend and myself, on various points in the design. On looking around for suitable materials, it was obvious that it was going to be very difficult to obtain supplies, especially castings, and the building of the locomotive would certainly be a long-term job. However, Mr. Adams made best use of whatever he could come by, and many small parts were made and set aside, ready for eventual erection; but some parts were made twice over, our friend having forgotten that he had previously made a similar component, so you can imagine how the job was dragging out! However, all difficulties were eventually surmounted, and the engine is now in service on the 52-ft. circle of the Falls Grove Railway. Mr. Adams has only three flat cars, but the engine hauls them, with all the passengers that can be squeezed on, quite easily. If there were sufficient cars available, a little sand might enable the whole outfit to emulate a dog chasing its tail. Working sanding gear will be fitted later.

The principal dimensions are as follow: Length of engine only, 3 ft. 7 in., length of tender 1 ft. 10 in. Coupled wheels $2\frac{7}{8}$ in. diameter. Cylinders 1 in bore, $1\frac{1}{2}$ in. stroke, with $\frac{3}{8}$-in. piston valves, oiled by a mechanical lubricator having a ram 5/32 in. diameter and $\frac{1}{4}$ in. stroke, driven by a 40-tooth ratchet-wheel. Boiler, 4 in. barrel; grate $9\frac{1}{2}$ in. by $3\frac{3}{4}$ in.; feed, one $\frac{3}{8}$ in. by $\frac{1}{2}$ in. pump, and one injector. The boiler is built according to the principles set out in these notes, has a combustion-chamber, three superheater flues, and a nest of $\frac{3}{8}$-in. tubes, and my recommended system of staying. It is lagged with asbestos sheet, and the cleading plates are of thin brass; the boiler bands are of thin copper, with pads on the end to provide a "hold" for the screws.

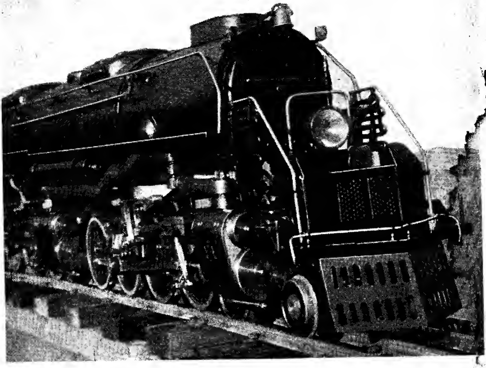


Mr. Ed. Adams's "Last Word"

Interesting Details

The frames were cut out of $\frac{3}{16}$-in. mild-steel; some job! The full-sized engine has a complicated system of compensated springing, but Mr. Adams thought this was too much of a good thing to reproduce in $2\frac{1}{2}$-in. gauge, so substituted plain bronze axleboxes with overhead coiled springs. The front set of coupled wheels, and the leading truck, are on a separate frame pivoted to a king-pin between the rear pair of cylinders, the front end sliding laterally on a seating under the smokebox, fairly strong springs being fitted at both places. This was necessary to equalise the load on the axles and minimise the chances of the front engine slipping, most of the weight being in the rear part. A little careful adjustment did the trick.

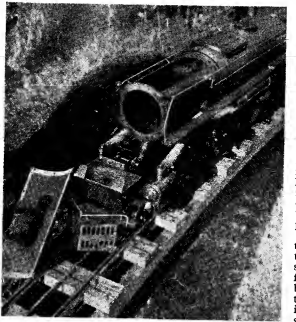
The steam- and oil-pipes have articulated joints, as shown in the detail illustration, which explains itself. Mr. Adams says that the glands have to be fairly tight, to prevent any slack-




4000

ing off when the engine is working. The exhaust from the front cylinders goes through an armoured gas-tube which, so far, has proved satisfactory.

Mr. Adams's previous experience with the building and operation of small locomotives has taught him the value of accessibility; and in this engine he has incorporated some ideas to that end. He says that detail and appearance take second place to accessibility, and with that I am in agreement; for, as he says, it is not only annoying, but a waste of valuable time to take half the engine down to get at some fiddling replacement or adjustment job. The latter antic is not unknown in full-size practice; I well remember a certain engine, the first of its class, which had an oil-pipe leading to the driving axlebox break on its trial trip. It was found necessary to lift the boiler to replace the pipe! It is hardly necessary to add that *that* defect was promptly remedied.



Making it get-at-able !

On the 4-8-8-4, not only is the front engine completely and readily detachable, but the upper part of the smokebox, complete with the double chimney, can also be easily taken off, as shown in one of the pictures. This allows of easy access to the front-end throttle, superheater-headers and connections, blast connections and nozzles, and blower; and also permits easy cleaning of the tubes and the interior of the smokebox. The front platform comes away also, and exposes the lubricator, ratchet-gear and drive.

Owing to the rear coupled wheels being under the firebox, the grate could not be arranged to dump in the usual manner, so the rear end is made to drop about $\frac{3}{8}$ in. and slide back under the cab, to get it out. When running, the grate is supported at the front end on a piece of angle, as specified for some of my boilers in these notes; and the rear end is held by a single pin passing through the backhead at the foundation-ring.

The grate was originally made from $\frac{1}{4}$-in. mild-steel bars at $\frac{3}{8}$ in. centres, shouldered down to $\frac{1}{8}$ in. at each end, and riveted into end bearers of $\frac{1}{8}$-in. by $\frac{1}{4}$-in. steel strip. This grate failed owing to the bars burning after 20 miles of running; the centre part was reduced to $\frac{1}{8}$ in., and the whole issue became badly distorted. To get over that trouble, our versatile friend made the centre part of the grate renewable; and the drawing shows how this was done. The centre part was cut away and short bearers were fitted as shown, two removable sections with stepped bars being made to fit the opening. These may easily be inserted through the firehole door, by aid of a pair of long-nosed pliers. The grate is easily cleaned by removing the centre part, and raking the residue through the hole into the double ashpan.

The firehole door is of the butterfly type, the two halves being connected by segments of gear-wheels, as shown in the accompanying illustration. The friction between the lever and quadrant is just sufficient to enable the door to "stay put" in any position.

The boiler fittings are all made to "Live Steam" specifications, the front-end throttle being a disc-in-a-tube with four holes in it. It is very sensitive, and works easily, opening at a touch. The sand-boxes on the boiler barrel are made from thin sheet copper hammered up over an oak former; the lids are turned, and furnished with wire handles, all ready for conversion to actual working sanders.

Electric lighting is fitted, and at present comprises a headlight and a portable cab lamp, which hangs at the side of the cab, and has a shield to throw the light on the gauges. Flash-lamp bulbs are used, the current being supplied by dry batteries housed in the left-hand air reservoir. The headlamp can be used to examine the smokebox, and the cab light to look in the firebox, when the engine is not under steam.

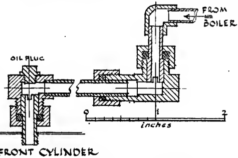
How She Runs

Steam is raised with the vacuum-cleaner motor gadget which was illustrated in these notes some time ago, a cork being used to plug one side of the double chimney, the suction-pipe of the fan being applied to the other side. When charcoal isn't available, oak sticks about $\frac{1}{2}$ in. square and 7 in. long, are used for lighting up, and it is easy enough to get up steam on these alone, though a few shovelfuls of ordinary house coal are usually thrown on the wood fire before making up with anthracite, on which the engine usually runs.

When the engine was first tried with a couple of passengers, she wouldn't steam, and this was solely because of insufficient draught with a light load. I gave friend Adams a few 'ints and tipses on blast and blower adjustments, and now he says it's a good job the safety-valves are efficient! She requires careful firing, as the large grate must be kept covered, without any holes to admit cold air; but the judicious application of a pricker, such as I have described in these notes, attends to the levelling-up all right. Mr. Adams says the big pressure gauge in the tender, recently illustrated, is a great help to the fireman; for, being very sensitive, it indicates instantly any slight drop in pressure which might be caused by a hole in the fire.

Noises in the Air!

Incidentally, I wonder how many readers of these notes have been close to a full-sized engine which has suddenly started to make a heavy rumbling sound, causing vibrations in the air which seem to shake the whole station? This is caused by a hole in the fire, and the blower drawing cold air through it. One Sunday evening about forty years ago or more, I was having a buckshee trip on one of the old London, Tilbury and Southend tanks, from the town famous for its cockles, to Fenchurch Street, and when we stopped at East Ham, three small boys came dashing up to have a close view of the engine. The fireman had let her run a bit low, as we were getting near home, and suddenly she started to make the awful rumble. The way those poor kids

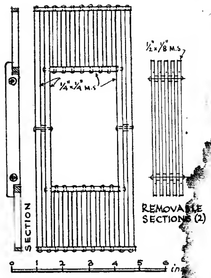


Articulated joints in steam pipes

scooted for dear life was just nobody's business! The nearest approach to the peculiar sound which I have ever heard was the rumbling which accompanied the explosions of Jerry's final bit of devilry, the "V2" rockets.

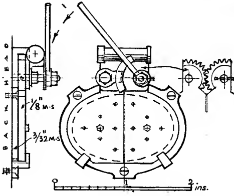
"Carting the Engine Around"

The locomotive is much too heavy to carry very far; and as it is some little distance from the workshop to the line, Mr. Adams followed the good example of the late "Bro. Wholesale," and provided wheeled transport. Our late and very much lamented friend fixed up a proper "pram," consisting of a heavy rectangular box-shaped body mounted on three pneumatic-tyred wheels, the whole issue being strong enough to carry a ton; he always "did things wholesale"! I have it here now, and it comes in very useful at times. Mr. Adams's vehicle is a sort of glorified



Construction of grate

scooter, consisting of a board with an axle at the rear end, on which are mounted two small pram-wheels. At the front end another pram-wheel is carried on what looks like a miniature cycle steering-column with forks complete. This swivels around like the front wheel of a Joy's invalid chair, making the whole bag of tricks easy to travel in any direction, or turn almost in its own length. A cover is fitted, made of bent plywood, to keep dust from settling on the engine.



Butterfly firedoor

The engine is at present reversed by a wheel and screw, but our friend says he will be fitting a power reverse, in the near future, in addition to the working sanding-gear. She is certainly some engine; I thought "Annabel," my 2½-in. gauge "Mallet" 2-6-6-4, was a pretty hefty specimen for that width of rails, but the Union Pacific job beats her. When thinking of the various

accomplishments of Mr. Adams, one might well emulate the sailor's parrot, and remark, "That was mighty fine—I wonder what he'll do next?"

A Few Odd Items

As the next instalment of drawings and notes on the "Maid" and the "Minx" won't be ready till next week, I might as well deal with a few of the queries in recent letters that are of general interest. Some of the prospective builders of the 5-in. gauge locomotives have asked if it is possible to arrange for full-sized blueprints to be made available as the description is proceeding, saying that they can work much better to a full-sized drawing than the small ones published in these pages with the notes. I am passing this request on to the Southern Railway draughtsman, Mr. Roy Donaldson, who makes proper tracings from my original drawings and gets them blueprinted; and if he can manage it, our advertisers will be able to supply the needful, so keep your eye on the "ad" columns.

Sifbronzing

I mentioned in the opening instalment that the frames could be erected by Sifbronzing or brazing, if desired, after the hornblocks had been fitted, instead of using angles, rivets and screws. This is the method I used on "Jeanie Deans" and "Grosvenor," and it certainly saves a lot of time, besides making a neat and sound assembly. The most important thing is to clamp the frames together so that nothing can shift when the heat is applied, and the metal starts to expand; even if the frames fit very tightly in the slots in the beams, they are likely to slip when the beam is heated. I use a couple of hardwood blocks between the frames, with a small carpenter's cramp over each, and as the heat from the oxy-acetylene blowpipe is merely "local," so to speak, they stand no chance of getting burnt; but for brazing, where the whole of the beam has to be made red-hot, metal packing would be necessary. A bit of iron pipe about $1\frac{1}{2}$ in. diameter, faced off each end in the lathe, to an overall length of $4\frac{1}{8}$ in., would be just the ticket.

The actual job is simplicity itself. Merely up-end the clamped-up frame assembly in the brazing-pan, put a dab of wet flux in each corner, and either heat each corner separately with an oxy-acetylene blowpipe, dropping in a few beads of Sifbronze, melted off a rod of No. 1 grade, or heat the whole beam with a blowlamp, and touch each corner with a bit of brass wire. Quench out in water, and clean off any burnt flux.

Followers of these notes who are building the engines to half-size, that is $2\frac{1}{2}$-in. gauge, should use 3/32-in. steel for frames, not $\frac{1}{16}$-in., and cut the hornblock openings to the dimensions given for "Austere Ada" and other similar-sized engines, viz. $\frac{3}{4}$ in. by $1\frac{1}{4}$ in., to accommodate the $2\frac{1}{2}$-in. gauge hornblocks sold by those of our advertisers who supply castings and material for "Live Steamers." The buffer beams can be made from $\frac{3}{4}$-in. by $\frac{1}{4}$-in. steel or brass angle, or may be castings; the width over the outside of the frames should be $2\frac{1}{8}$ in.; buffer and drag beams $4\frac{1}{2}$ in. long, and buffer centres $2\frac{15}{16}$ in.

Oil for Lubricators

Tip: don't use oil impregnated with colloidal graphite in small mechanical lubricators with rams only 3/32 in. diameter, or they may become choked and refuse to pump at all. Colloidal graphite is supposed to be practically "soluble" in oil, but it is something like cocoa, inasmuch as it will appear to have dissolved when the liquid is stirred, but doesn't remain in suspension, settling to the bottom of the container if the contents are left for some time, like the residue you see in the bottom of the cocoa cup after you drank the last half without stirring it again. You may have noticed that I recommended the use of colloidal graphite for engines with displacement lubricators, but have made no mention of same for use in mechanical lubricators. The reason is as above. I don't know whether graphite in the oil would affect the working of Mr. Cottam's ingenious sight-feed gadget; probably it wouldn't. Anyway, it certainly does the port-faces, valves, cylinder bores and pistons a bit of good if a little colloidal graphite can be introduced from time to time; and if you wish to do it on a mechanically-lubricated engine, the simplest way is to drill a small hole, say, about 5/32 in., in the steam-chest cover of each cylinder, tap it $\frac{3}{16}$ in. by 40, and make a hexagon-headed screw plug to fit. A little "dope" of cylinder-oil treated with colloidal graphite can then be introduced by means of a syringe with a bit of $\frac{1}{8}$-in. pipe for a spout—sort of "giving her an injection!" The syringe can be home-made from a bit of the same tube used for boiler tubes; any scrap end will do, a "block" piston being turned to fit, and furnished with a $\frac{3}{16}$-in. piston-rod with a thumb-button screwed on the end. In the case of inside-cylinder engines, a tube could be screwed into the steam-chest cover and brought to the outside of the smokebox, a small cap being screwed on the end of the pipe. All Billy Stroudley's engines had a couple of brass "dope cups" on the front of the smokebox under the door, and we used to give them a frequent shot of cylinder-oil and tallow, mixed up hot. It kept the valves and pistons in fine condition, and was a great help to the old displacement lubricators which every engine had to make do with in those days.

Cars and Locomotives

Some of our readers have been noting the speeds put up by miniature race cars, and want to know why I don't get busy and give details of a little steam car which would knock spots off any I.C.-engined car yet put on the race track. Bless your hearts and souls! I've got quite enough on my plate, keeping up the locomotive articles alone, without bothering about race cars; but I might tell you this. All that prevents our little locomotives travelling at the *actual* speed of their 4 ft. $8\frac{1}{2}$ in. gauge relations is Dame Nature—she won't let them keep the rails; a test-stand trial of a little locomotive has proved that she could turn her wheels fast enough to run "neck and neck" with her full-sized sister!

A "Table" Camera Tripod

by "Arty"

WHEN the enthusiastic model engineer has successfully completed a model, it naturally becomes his earnest desire to record this feat for posterity by a photograph or two. For this purpose, a small camera tripod of the type known as a "table" tripod is a great convenience if not a necessity. Full working drawings of such a tripod are given here. I have altered the design slightly from my own in the light of experience in construction and use. There is little more to be said except for some random notes and to express the desire that these drawings will prove useful or provide a basis for a better design.

Notes

(a) Part No. 2 is a standard 1-in. diameter ball-bearing. It will naturally be necessary to soften this before drilling and tapping for Part No. 1. It should be possible to do this if care is exercised without loss of spherical shape or surface finish (although the shine will be lost).

(b) Parts Nos. 3 and 5 were originally made in

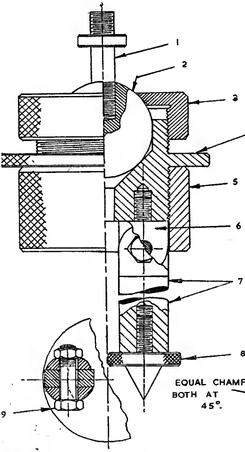


Fig. 1. *General arrangement*

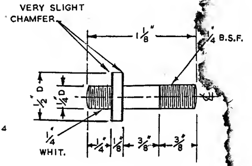


Fig. 2. *Part No.* 1

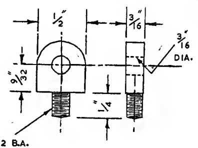
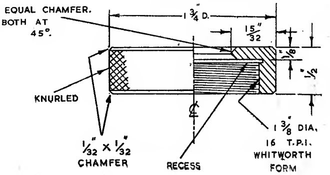


Fig. 6. *Part No.* 6



Right—Fig. 3. *Part No.* 3

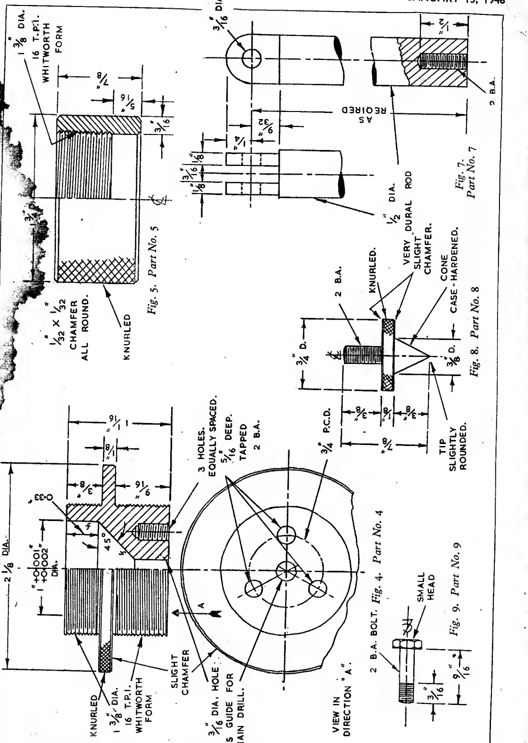


Fig. 5. Part No. 5

Fig. 7. Part No. 7

Fig. 8. Part No. 8

Fig. 4. Part No. 4

Fig. 9. Part No. 9

brass in preference to dural for easier turning. In the light of experience I would suggest the use of dural despite this difficulty, in order to lighten the head of the tripod.

(c) Part No. 4 is necessarily made in mild steel because the three parts No. 6 are brazed in position.

(d) The length of the legs, Part No. 7, can, of course, be made any length required, but it will be found desirable to keep them fairly short, say not more than 9 in.

(e) The thread on the top of Part No. 1, which mates with the boss on the camera is shown $\frac{1}{4}$-in. Whitworth, which is the British standard but, of course, the continental thread may be used if required.

(f) It was originally proposed to manufacture rubber tips as an alternative to the steel tips, Part No. 8, but this was not proceeded with owing to lack of time.

(g) Adjustment of the lower ring, Part No. 5, affords a measure of control over the spread of the legs.

(h) For ease of transportation, is is suggested that a spring clip be made to hold the legs together when the tripod is not in use.

PART Nº.	MATERIAL	Nº OFF
1	M.S.	1
2	HARD STEEL	1
3	DURAL	1
4	M.S.	1
5	DURAL	1
6	M.S.	3
7	DURAL	3
8	M.S.	3
9	——	3

Fig. 10. *Part schedule*

Editor's Correspondence

Boats that Go Backwards

DEAR SIR,—Having read Mr. Westbury's article on the above subject, and whilst I do agree that 1947 has been a bad year as regards the performance of many boats, I do not agree with his theories as to the cause of this. Many of the crack boats that performed so well before the war are not giving of their best now, owing to inferior fuel and general fatigue of the metals used in the construction of the engine, resulting in frequent breakages. In addition to this, most of these boats have been laid up during the war years and the hulls have dried out and warped, causing alteration to planing surfaces, etc. This period of inactivity has also resulted in a certain amount of corrosion of highly finished bearing surfaces (not to be wondered at in engines that do all their running in close proximity to water). Several flash steam boats have been put out of the running during 1947, owing to the rusting of the steel tubing in the boilers, this tubing being very difficult to obtain.

The majority of these pre-war boats took several years of development before they reached their optimum efficiency, and it is only to be expected that the new boats which took the water for the first time in 1947 will need a similar period of development. It must be remembered that Gremlins were not reduced in number by the war, rather to the contrary!

Yours faithfully,

Orpington. G. A. LINES.

DEAR SIR,—I was very interested in the above article on November 27th and the criticisms therein. Although I have had very little trouble with getting my boat away, using an air shutter worked by the usual delayed-action mechanism, I very much like the idea of using a throttle. I think, however, unless carefully designed, it would just as likely produce the same results as an air shutter. For this reason, I should like to know whether there is a possibility of a few tips in this direction in a future article, preferably adaptable to existing carburettors.

Speaking of the "conking-out" epidemic at a recent regatta, my theory (I can only claim it as a theory) is that, in addition to the weakening of the mixture due to rapid opening of the air-slide the boat is suddenly jerked sideways when reaching the end of a slack line causing a rush of air through the intake and further weakening the mixture and causing a sudden drop in power. A temporary cure for this would be to slow up the action of the delay-gear, till this critical point was passed.

Regarding the poor showing of hydroplanes these days, I think part of the reason is that model power boats have serious rivals in model petrol planes and cars, and the trade supports these more than boats. Granted, the "C" class have benefited, but unless built and run by an expert, the results are very disappointing. What is wanted is fresh blood and more support from the trade for the larger classes of engines.

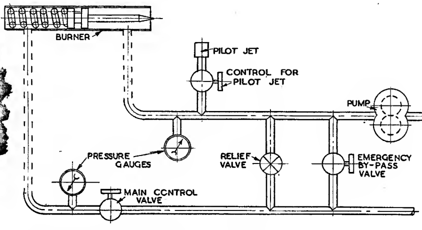
May I also suggest perhaps an article on any existing designs of engines suitable for speed-boats may bring fresh enthusiasm, especially as motorists and motor-cyclists deprived of their "basic" may turn their attention to building these engines.

Yours faithfully,

Carshalton. E. A. WALKER.

Small Gas Turbines

DEAR SIR,—With reference to the letter in the "Editor's Correspondence" by "Arty" (December 11th, 1947). The uncontrollable accelerations of the rotor in the early gas turbines by Whittle were attributed to the following causes. The first being due to pools of liquid fuel forming in the combustion chamber caused through the fuel line being broken when making various alterations and some of the fuel they contained draining into the combustion chamber. When the gas turbine was started again it accelerated out of control until the surplus fuel had been consumed. Another cause can be seen if reference is made to the diagram herewith.



It can be seen that if the control line had been drained during alterations in the fuel system, when the fuel pump was started, the needle valve in the burner would be forced into an open position, control not being gained until the control line again filled with fuel. Yet another cause was through loss of temper in the burner needle-spring. This type of control is not now used. None of the uncontrolled accelerations took the rotor over 9,000 r.p.m. The usual types of fuel systems used in full-sized aircraft jobs work with a pump constructed with a swash plate, the angle of which can be varied from 81 deg. to 90 deg. from the axis of its shaft, working a multiple of small simple pump units, as in the Rolls-Royce Nene. Alternating a constant stroke pump supplying more fuel than is required, the surplus being bled off through either the control or relief valve as in the "De Havilland Goblin." Approximately 1 per cent. of lubricant is added to the paraffin fuel to lubricate the mechanisms in these fuel systems. Accessories such as barostats (to maintain the correct fuel-air ratio at varying air density), automatic dumping valves, and so on, may be ignored on experimental gas turbines where constant supervision can be kept on their performance during running. To assure thorough atomisation of the fuel over a wide range of speeds, it would be essential to have a controllable needle valve in the burner jet or alternatively a duplex burner. The construction of a duplex burner, with its special valve, would not, in my opinion, at this stage, warrant the time spent on its construction until a satisfactory miniature gas turbine has been produced.

Yours faithfully,

Crewe. R. R. COULTHARD.

Design of Bearing Seals

DEAR SIR,—I have been interested in references to the use of piston rings for bearing sealing in your issues of July 10th and December 4th, as this precise method has been used to seal STUART two-stroke engine crank-cases for no less than 20 years.

Whether the method had been used before I do not know, but as so little is really new, it probably has been used much earlier.

Generally I can endorse "Don's" advice, but certain other notes may be useful.

(1) The shaft or collar in which the grooves are cut must have a clearance in the bore—0.002-3 in. is usually enough. Careful tests have shown that air leakage is not increased by a clearance of 0.015 in. Concentricity is also important.

If there is actual contact between the rotating member and the bore, a burr is often raised on the edge of the groove. This causes the ring to seize in the groove and it then rotates in the bore, causing heavy damage and even complete seizure.

(2) Cast-iron rings $\frac{1}{16}$ in. wide are usual, but deep section bronze rings have been used and and with great success, but a two-piece collar is then essential, as the rings cannot be sprung into position without distortion. This is fatal, as the ring then does not fit the bore, and obviously it will never run in. The collar is simply one part, with a spigot to suit the ring, and a second part which is a plain washer.

(3) Keep end play down to a minimum.

(4) Two narrow rings in a double width groove are often very successful.

I hope these extra points will be useful.

Yours faithfully,

Henley-on-Thames. A. F. PLINT, M.I.Mech.E.

Experimental Work

DEAR SIR,—I do not think that Mr. Harris need be unduly perturbed by the observations of Professor Read, well-meant and true though they are; for much may be said on both sides.

Most of us can throw a ball up and catch it, a few can keep two in the air at once, but it requires a juggler to keep three going. To ordinary engineers like most of ourselves, therefore, I say: if possible, keep to one variable and observe its effects.

Of course, as Professor Read has stated, variables are so often inter-related that it is quite impossible to vary one at a time. As an example, seven variables are involved in the simple case of heat flow through a tube. In these circumstances we are forced to the use of dimensionless groups, first suggested by Osborne Reynolds, and although the plotting of such groups extends the range of the experiments, it often renders interpretation a good deal more difficult.

The statement "... as many separate tests should be carried out under each set of conditions as is feasible and convenient" does not appear to me as meaningless as Professor Read would have us believe.

Take Measurements

As one who first obtained experience on the testing of engines by going to sea with them, I would encourage everyone to take every measurement he possibly can. Many of the measurements may be redundant for the particular trial, but would be of value for a subsequent analysis, and they may afford some confirmation of readings which are in doubt.

It is a most exasperating experience to return to the office after a voyage and find you are short of some reading, or some instrument has been faulty.

Experimental work in laboratories where repeat tests can be made is one thing. Under service conditions it is another, especially if you have to cope with the intolerable heat and illiterate helpers.

Yes, Mr. Harris, one step enough for me, whether I am concerned with testing an engine, or it is testing me in an effort to get it going.

Yours faithfully,
Sunderland Technical College. D. A. WRANGHAM. Principal.

Early Passenger Hauling

DEAR SIR,—I was interested in "L.B.S.C.'s" historical note of December 11th. In THE MODEL ENGINEER issued May 23rd, 1907, the fact is recorded that a Carson 2½-in. gauge engine hauled a 10-stone man on a double bogie truck. This event is some fourteen years prior to the one mentioned by "L.B.S.C." for adult loads on 2½-in. gauge.

In the issue for June 10th, 1909, T. W. Averill described a 4-6-4 tank locomotive for 3½-in. gauge, which pulled from a dead start, a load of 845 lb. behind the engine. This engine is mentioned in the article as being the one which amazed the G.W.R. driver.

The Averill 5-in. gauge Atlantic was described in July, 1911, and details are given of a 1,148-lb. load behind the tender. From the drawings, it is seen that the trucks had plain journal bearings.

No mention is made of the nature of the truck bearings in the other two cases; but it is probably safe to assume that if roller or ball-bearings had been fitted to the cars, a much greater load may have been moved from rest.

Boilers

Another point of interest is that the three locomotives, apparently, had Smithies-type boilers. Averill favoured this form of boiler. This calls to mind, that in Greenly's *The Model Locomotive*, published in 1904, there is a description and also a Messrs. Flooks & Smithies advertisement, of a single-cylinder (⅝ in. × 1¼ in.) locomotive for 3¼-in. gauge. This engine is referred to in *Models, Railways and Locomotives* for November, 1912, wherein it is stated that the locomotive pulled the writer of the article at a good speed. Perhaps this was the first single-cylinder passenger hauler on a narrow gauge.

A further example of a small tank engine, possibly having a claim to fame, is that mentioned in *Model Railways* for November, 1910. This 3½-in. gauge engine set up a non-stop record of three miles. The track supplemented the 7¼-in. gauge line of the late Mr. G. Mitchell, to whom the engine belonged. Subject to correction, this is probably the earliest example of a continuous passenger-hauling track for so narrow a gauge.

Yours faithfully,
H.J.H.

"Lord Kitchener"

DEAR SIR,—I am happy to note that my article "Old Soldiers Never Die...." has struck a responsive note in some of "our" readers—I have had a few personal letters besides those you have published.

The present reason for writing, indeed, is to answer publicly a query which one of these personal correspondents asked, since the same query may have occurred to others. The question is "How can you be certain *to the nearest* ⅛ *in.* what each individual measurement is—e.g., distance external edge of flywheel rim to vertical C.L. of boiler is 1 ft. 7⅛ in.? This must be *very difficult* in measuring from the engine itself!" [Do I suspect a slight sarcasm in the last sentence?]

However, the answer is easy. I spent the best part of a day in overalls crawling over, under, and around this engine, taking measurements as accurately as possible. I wrote my article. And then I came into possession of a print of one of these engines, *made from Fowler's original tracing*, and was able to check my measurements from this. Several corrections were needed, but the *largest* discrepancy was only ¼ in.

Of course, all necessary alterations were made before the article was sent for publication, and the figures may be taken as correct, therefore.

Yours faithfully,
Sheffield. W. J. HUGHES.